

allowing the hard mask to react with etch process gases forms a skin on the hard mask that is harder than the hard mask.

56. (New) A method according to claim 53, further comprising:

selecting a hard mask that will react with the etch process gases in order to harden the hard mask.

Remarks

The above Amendments and these Remarks are in reply to the Office Action mailed May 22, 2002. Claims 1 and 42-50 were pending in the Application prior to the outstanding Office Action. In the Office Action, the Examiner rejected claims 1 and 42-50. The present Response amends claim 1 and adds new claims 51-56, leaving for the Examiner's present consideration claims 1 and 42-56. Reconsideration of the rejections and consideration of the newly added claims is respectfully requested.

I. Rejection Under 35 U.S.C. §102

Because it is not explicitly stated in the Office Action which claims are rejected, and due to some uncertainty related to the 103 rejection addressed below, claims 1 and 42-50 will be addressed under 35 USC §102(b) in order to show that they are not anticipated by *Nakagawa* (US 5,126,288). Claim 1 as amended recites the limitation of "oxidizing the hard mask in order to harden the hard mask". *Nakagawa* does not disclose such a limitation. As such, *Nakagawa* cannot anticipate claim 1. Claims 42-50 depend from claim 1, and are therefore also not anticipated by *Nakagawa*. Applicants therefore respectfully request that any rejection under 102(b) with respect to claims 1 and 42-50 be withdrawn.

II. Rejection under 35 U.S.C. §103

Claim 50 is rejected under 35 U.S.C. §103(a) as being obvious in over *Nakagawa* in view of *Hashimoto* (US 5,320,979). It is not clear from the rejection whether claim 50 was correctly identified as the rejected claim, as the limitation recited by the Examiner is not found in Applicants' claim 50. Similar but different limitations are found, for example, in claims 43 and 44. Applicants will therefore address the rejection with respect to previously pending claims 1 and 42-50.

As discussed above, claim 1 as amended recites the limitation of "oxidizing the hard mask in order to harden the hard mask". Also as discussed above, *Nakagawa* does not disclose such a limitation. Neither does *Hashimoto* teach or suggest such a limitation.

The Examiner has stated, but has not pointed to where, the *Hashimoto* reference teaches oxidizing a metal surface in order to slow down the etch rate of a hard mask. *Hashimoto* teaches a method of tapering a sidewall of a connection hole for connecting wirings. A taper is formed in the connection hole by the "selective sputter etching by oxygen ions" (col. 4, lines 31-35), as the "oxygen ions are used as etching ions" (col. 6, lines 52-56). Gas supply mechanism 35 can supply an etching gas such as oxygen gas, which can be used for "high-speed sputter etching by oxygen ions" (col. 5, lines 2-3). *Hashimoto* does not teach "oxidizing the hard mask in order to harden the hard mask", but instead teaches using oxygen as an etchant gas.

Further, claim 1 recites that the "layer is etched corresponding to the pattern of the hard mask, and the growth of the layer during the etch is minimized in the portion of the layer corresponding to the critical dimension." The use of oxygen ion etching in *Hashimoto* is to accomplish tapered sidewall etching. *Hashimoto* does not use a hard mask, and does not etch according to a pattern of a hard mask. *Hashimoto* also does not teach oxidizing a "hard mask in order to harden the hard mask". *Hashimoto* therefore does not render claim 1 obvious.

There is no suggestion to combine *Nakagawa* and *Hashimoto*. *Nakagawa* is not attempting to etch tapered sidewalls or connect wirings through a connection hole, so there would be no motivation to look to *Hashimoto*. Neither is there any suggestion in either reference to combine the teachings of the references.

Even if combined, *Nakagawa* and *Hashimoto* do not render claim 1 obvious. Neither of the references, alone or in combination, teaches “oxidizing the hard mask in order to harden the hard mask”, such that “the layer is etched corresponding to the pattern of the hard mask, and the growth of the layer during the etch is minimized in the portion of the layer corresponding to the critical dimension.” Even if the high-speed sputter etching by oxygen ions of *Hashimoto* is used with the oblique vapor deposition of a hard mask of *Nakagawa*, there is no teaching or suggestion that the resultant process would harden the hard mask such that “the layer is etched corresponding to the pattern of the hard mask, and the growth of the layer during the etch is minimized in the portion of the layer corresponding to the critical dimension.” As such, *Hashimoto* and *Nakagawa* cannot render claim 1 obvious, either alone or in combination.

Claims 42-50 depend from claim 1. As claim 1 is not rendered obvious by *Hashimoto* and *Nakagawa*, neither are claims 42-50 rendered obvious. Applicants therefore respectfully request that the obviousness rejection be withdrawn.

III. Newly Added Claims

Claims 51-56 have been added to more particularly point out and distinctly claim the subject matter which Applicants regard as the invention. These claims are supported by the specification and do not add new matter to the disclosure. Applicants respectfully request that the new claims be considered.

IV. Amendments to the Claims

Claim 1 has been amended in order to clearly and particularly point out and distinctly claim that which is regarded as the invention of claim 1. The amendment is not intended to alter the scope of the claim or in any way limit any equivalence thereof.

V. Conclusion

In light of the above, it is respectfully submitted that all of the claims now pending in the subject patent application should be allowable, and a Notice of Allowance is requested. The Examiner is respectfully requested to telephone the undersigned if he can assist in any way in expediting issuance of a patent.

The Commissioner is authorized to charge any underpayment or credit any overpayment to Deposit Account No. 06-1325 for any matter in connection with this response, including any fee for extension of time, which may be required.

Respectfully submitted,

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APPENDIX

In the Claims:

1. (Twice Amended) A method for etching a pattern on a workpiece, comprising:
selecting a workpiece with a hard mask deposited over a layer to be etched, which hard mask is comprised of a reactive metal, the hard mask further defining a pattern including at least one portion having a critical dimension; [and]

oxidizing the hard mask in order to harden the hard mask; and

processing the workpiece in a reactor by exposing the entire hard mask to an etch;

whereby the layer is etched corresponding to the pattern of the hard mask, and the growth of the layer during the etch is minimized in the portion of the layer corresponding to the critical dimension.

51. (New) A method for etching a pattern on a workpiece, comprising:

selecting a workpiece with a hard mask deposited over a layer to be etched, which hard mask is comprised of a reactive metal and defines a pattern including at least one portion having a critical dimension;

allowing the hard mask to react with etch process gases in order to harden the hard mask;

and

processing the workpiece in a reactor by exposing the entire hard mask to an etch;

whereby the layer is etched corresponding to the pattern of the hard mask, and the growth of the layer during the etch is minimized in the portion of the layer corresponding to the critical dimension.

52. (New) A method according to claim 51, wherein:

allowing the hard mask to react with etch process gases forms a skin on the hard mask.

53. (New) A method for etching a pattern on a workpiece, comprising:

processing a workpiece using etch process gases, the workpiece having a hard mask deposited over a layer to be etched, which hard mask is comprised of a reactive metal and defines a pattern; and

allowing the hard mask to react with the etch process gases in order to harden the hard mask, whereby the layer is etched corresponding to the pattern of the hard mask and the hardening of the hard mask holds the pattern of the hard mask being etched into the layer.

54. (New) A method according to claim 53, wherein:

the hard mask further defines a pattern including at least one portion having a critical dimension; and

wherein the growth of the layer during the etch is minimized in the portion of the layer corresponding to the critical dimension.

55. (New) A method according to claim 53, wherein:

allowing the hard mask to react with etch process gases forms a skin on the hard mask that is harder than the hard mask.

56. (New) A method according to claim 53, further comprising:

selecting a hard mask that will react with the etch process gases in order to harden the hard mask.